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A REVIEW

Role of Low Acid Diet In Chronic Kidney Disease

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ABSTRACT : **Introduction-** Acid-base balance is maintained by normal elimination of carbon dioxide by the lungs (which affects the partial pressure of carbon dioxide (PCO_2) and normal excretion of non-volatile acid by the kidneys (which affects the plasma bicarbonate concentration). The role of dietary acid also should be given greater consideration in CKD patients. **Objective-** The objective of the study was to know the effect of dietary intervention of Low Acid Diet on (CKD) Chronic kidney disease outcomes. **Methodology-** It is a hospital based interventional study. Patients were recruited from nephrology OPD of Sir Sunderlal Hospital IMS BHU Varanasi, India in the age group of eighteen years and above who were ready to give written consent. Follow-up has been done for six months. Study variables were BMI, Demographic profile, Glomerular filtration rate, bicarbonate level by ABG, Blood levels of Urea, Creatinine. Investigative variables were obtained by standard methods as used in the hospital. Study tools used were Interview Schedule, Electronic weighing scale, Measuring tape, Food frequency questionnaire (FFQ) and 24hr. dietary recall method were applied for dietary assessment. Data were analyzed by trial version of SPSS 16 software. **Results-** Results shows that serum bicarbonate was increased from less than 23mmol/L in 5 patients to more than 23mmol/L in 8 patients. Reduction was found in CKD stages 2 and 5. In dietary habits fruit intake was found increased who were taking 2-4 servings per day likewise frequency of 3 servings per day of vegetable intake was found increased from 4 patients to 12 patients. **Conclusion** -Present study suggest that intervention of low acid diet by increasing fruits and vegetable intake holds promise to be an additional kidney-protective strategy in CKD management.

KEY WORDS :
Metabolic acidosis, Dietary intake, Bicarbonate, Chronic kidney disease, ABG (Arterial blood gases)

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Chronic Kidney Disease (CKD) is when kidneys are damaged or a decline in renal function is found by decreased glomerular filtration rate (GFR) at least for three or more (Levey *et al.*, 2003). As Chronic Kidney Disease (CKD) burden is increasing worldwide. In developing countries like our country India, limited financial resources and scarcity of infrastructure are the hindering factors on existing health policies in respect of the increasing burden of CKD and other diseases. The correct prevalence of CKD in India is not clear due to lack of adequate data recording systems both in the Government and insurance sectors (Rajapurkar and Dabhi, 2010). There are only three studies which have been carried out in different parts of India have been reviewed to examine the prevalence of CKD, which was found from 0.79 per cent to 1.4 per cent. The disease profile of the world is now changing and

chronic diseases contribute for the majority of global morbidity and mortality, rather than other infectious diseases. The chronic kidney diseases and diabetes, together with hypertension, is the major cause of end-stage renal failure worldwide today, not only within the developed world, but also increasingly within the emerging world.

The daily consumption and production of acids and bases is in balance with their excretion in healthy individuals, which is resulting in a tightly regulated and stable state of acidity (pH) of body fluids (Narins *et al.*,1994). This shows that the renal net acid excretion and daily net fixed acid production are equal (Lennon *et al.*,1966). A normal person generates ~1 mEq of non-volatile acid/kilogram body weight/ day (Narins *et al.*, 1994). Maintaining acid–base balance by excreting acid in amounts that are equal to the extra renal acid production is one of the major roles of the Kidney. The kidneys achieve this firstly by reclaiming filtered bicarbonate and secondly by regenerating base by the excretion of ammonium and titratable acid. A small trial of patients with early CKD showed that addition of fruit and vegetable intake can lower net acid excretion by about one third and was comparable to administration of 0.5 mEq/kg/day of sodium bicarbonate (Goraya *et al.*,2012). Modern diets that are highly acidic and can lead to metabolic acidosis, when access of acid builds up in the body. because kidneys are responsible for removing acid through the urine so this is more common in patients with CKD. Metabolic acidosis is found in the majority of patients with CKD when (GFR) decreases to less than 20 per cent to 25 per cent of normal, although as many as 20 per cent of individuals can have acid-base parameters close to or within the normal range. Many adverse conditions have been associated with metabolic acidosis, such as impaired growth, muscle wasting, bone disease, progression of renal failure thyroid hormone secretion, abnormalities in growth hormone, impaired insulin sensitivity and exacerbation of beta 2 -micro globulin accumulation (Kraut and Kurtz, 2005).

Dietary modification is an integral part of renal therapy. Patients with chronic kidney disease have quite different nutritional requirement rather than those of the normal people and planning the diet for CKD patients require thorough knowledge of various physiologic and pathologic processes related to renal system. Assessment of nutritional requirements and planning modifications in dietary components among patients with various co-morbid diseases is a tough job. Dietary factors are an important component in the treatment of kidney diseases to minimize the complications increasing sdue to renal insufficiency. Hence, a balance diet according to the disease stage and activity needs to be prescribed.

RESEARCH METHODOLOGY

Hypothesis :

Base-inducing foods (fruits and vegetables) could slow the rate of decline of kidney function in patients with Chronic kidney disease.

Objectives :

Objective of the study was to find the effect of low acid diet on CKD outcomes.

Research question :

Research question of the study was what is the effect of low acid diet counselling on CKD patients.

Study design :

Hospital based Interventional study.

Study subjects :

Patients were recruited from nephrology OPD of Sir Sunderlal Hospital IMS BHU Varanasi, in the age group of eighteen and above irrespective of their gender. Informed written consent was taken from the respondents.

Inclusion criteria 1**:**

Patients of chronic kidney disease from stage one to five measured by modification of diet in renal diseases (MDRD), formula for GFR (ml/min/1.73 m^2)

$$\textbf{GFR (Female)} = 175 \times (S.cr)^{-1.154} \times (Age)^{-0.203} \times (0.742)$$

$$\textbf{GFR (Male)} = 175 \times (S.cr)^{-1.154} \times (Age)^{-0.203}$$

– Patients who will be able to understand and agree for informed consent for the participation in this study.

Exclusion criteria :

–Patient undergone or underwent dialysis within three months.

–Patients who were disable or immobile.

–Patients who were admitted in the hospital within last one month for any reasons (Infection/cardiac failure

etc.).

– Patients on parenteral nutrition.
– Patients with acute infection.
– Patient with associated chronic liver disease (CLD), congestive heart failure (CHF),HIV, active tuberculosis.
– patients already taking oral sodium bicarbonate supplement.

Study variables :

Study variables will be height, weight, demographic profile like total family members, family income etc., glomerular filtration rate, plasma bicarbonate level by ABG, blood levels of urea, creatinine, sodium, potassium, phosphorus, calcium uric acid, serum albumin,serum globulin.

Data collection :

The baseline information was collected and then one monthly follow up was done for six months. Their dietary acid consumption were assessed using 24 hr.dietary intake and plasma bicarbonate level. Plasma bicarbonate level were checked at initial level and after six months of follow-up by (ABG) arterial blood gasses. Other investigative variables were obtained by standard methods as used in the Sir Sunderlal hospital.

Description of intervention :

Diet counselling was done at the time of registration for low acid diet in that fruits and vegetables which are allowed in chronic kidney disease were emphasized. Further one monthly follow-up was done for dietary re-counselling upto six months.

Study tools :

Interview schedule, electronic weighing scale, measuring tape, food frequency questionnaire (FFQ) and 24hr. dietary recall method were applied for dietary assessment.

Analysis :

Data were entered and analyzed by SPSS software.

RESULTS AND DISCUSSION

A total of twenty patients were included in the study age distribution of patients were 4 (20%) in the age group of 18-39 years. Maximum 12 (60%) in the age group of 40-49 years, male 13 (65%) were more in comparison to 7 (35%) female. Maximum respondents belong to nuclear family 14 (70%). About similar proportion were found in patients from urban 8 (40%) and rural 7 (35%) areas.

Slight shift was found in body mass index from 25-30kg/m^2 and $\geq$ 30kg/m^2 after incorporation of low acid diet. Serum bicarbonate was found increased after intervention from 4 (20%) to 8 (40%) in above 23mmol/lit.

Table 1 : Demographic characteristics of the study subjects

Variables		Frequency	Percentage	Total N (%)
Age	18-39	4	20	20(100)
	40-59	12	60	
	60 and above	4	20	
Sex	Male	13	65	20(100)
	Female	7	35	
Family type	Nuclear	14	70	20(100)
	Joint	6	30	
Locality	Urban	8	40	20(100)
	Semi urban	5	25	
	Rural	7	35	

Fruit intake was increased from 2(10%) to 4 (20%) and from (0%) to 2 (10%) who were taking twice a day and thrice a day, respectively. If we look at vegetable intake in chronic kidney disease patients who were taking less than once a day, huge reduction was found from 9 (45%) to 0 (0%). Frequency of taking three servings of vegetable a day increased from 4 (20%) to 12 (60%). Vegetable intake was increased from 1(10%) to 4 (20%) and from 0 (0%) to 1(10%) who had frequency of 4 servings a day and 5 servings a day, respectively.

A study by Goraya N in 2012 (Goraya *et al.*, 2012). compared the efficacy of alkali-inducing fruits and vegetables with oral sodium bicarbonate to diminish kidney injury in patients with hypertensive nephropathy at stage 1 or 2 estimated GFR. All patients were evaluated for 30 days after no intervention; daily oral sodium bicarbonate; or fruits and vegetables in amounts calculated to reduce dietary acid by half. All patients had 6 months of antihypertensive control by angiotensin-converting enzyme inhibition before and during these studies, and otherwise ate *ad lib*. Indices of kidney injury were not changed in the stage 1 patients. By contrast, each treatment of stage 2 patients decreased urinary albumin, *N*-acetyl β-D glucosaminidase and transforming growth factor β from the controls to a similar extent. Fruits and vegetables appear to be an effective kidney protective adjunct to blood pressure reduction and angiotensin-converting enzyme inhibition in hypertensive and possibly other nephropathies.

Scialla and Anderson (2013) in their study says that

Table 2 : Changes in BMI before and after intervention

BMI	≤18.5kg/m^2 (%)	18.525kg/m^2 (%)	25-30 kg/m^2 (%)	≥30kg/m^2 (%)	Total no (%)
Pre-intervention	4(20)	12(60)	2(10)	2(10)	20(100)
Post-intervention	4(20)	13(65)	3(15)	1(5)	20(100)

Table 3 : Frequency of fruit intake before and after diet counselling

Fruit intake per day	≤ I (%)	II (%)	III (%)	Total no (%)
Pre-intervention	18(90)	2(10)	0(0)	20(100)
Post-intervention	14(70)	4(20)	2(10)	20(100)

Table 4 : Frequency of vegetable intake before and after diet counselling

Vegetable intake day per	≤ I (%)	II (%)	III (%)	IV (%)	V (%)
Pre-intervention	9(45)	6(30)	4(20)	1(5)	0(0)
Post-intervention	0(0)	3(15)	12(60)	4(20)	1(5)

Table 5: Frequency of meals before and after intervention

No. of meals per day	II (%)	III (%)	IV (%)	V (%)	VI (%)	Total no (%)
Pre-intervention	5(25)	4(20)	6(30)	5(25)	0(0)	20(100)
Post-intervention	1(1)	0(0)	3(15)	13(65)	3(15)	20(100)

Table 6 : Frequeny of serum bicarbonate level before and after intervention

Serum bicarbonate	≤ 23mmol/L(%)	≥ 23mmol/L (%)	Total no (%)
Pre-intervention	16(80)	4(20)	20(100)
Post-intervention	12(60)	8(40)	20(100)

Table7 : Changes in stages of CKD after intervention

Stage of CKD	II (%)	III (%)	IV (%)	V (%)	Total no (%)
Pre-intervention	2(10)	6(30)	9(45)	3(15)	20(100)
Post-intervention	1(5)	7(35)	10(50)	2(10)	20(100)

non-volatile acid is produced from the metabolism of organic sulfur in dietary protein and the production of organic anions during the combustion of neutral foods. Organic anion salts that are found primarily in plant foods are directly absorbed in the gastrointestinal tract and yield bicarbonate. The difference between endogenously produced non-volatile acid and absorbed alkali precursors yields the dietary acid load, technically known as the net endogenous acid production, and must be excreted by the kidney to maintain acid-base balance. Although typically 1mEq/kg/day, dietary acid load is lower with greater intake of fruits and vegetables. In the setting of CKD, a high dietary acid load invokes adaptive mechanisms to increase acid excretion despite reduced nephron number, such as increased per nephron ammonia genesis and augmented distal acid excretion mediated by the renin- angiotensin system and endothelin-1. These adaptations may promote kidney injury. Additionally, high dietary acid loads produce low-grade, subclinical acidosis that may result in bone and muscle loss. Early studies suggest that lowering the dietary acid load can improve subclinical acidosis, preserve bone and muscle, and slow the decline of glomerular filtration rate in animal models and humans (Scialla and Anderson, 2013).

Reddy *et al.*, 2002 noted that consumption of a high protein diet for six weeks was associated aciduria and urinary calcium and claimed that this constituted increased risk of stone formation in ten healthy subjects although none of the ten subjects developed renal stones. The severe carbohydrate restriction imposed in this study may have increased keto-acid production thereby contributing acid formation. Since consumption of fruits and vegetables usually produces a marked base load Cordain *et al.*, 2005, restriction of these foods subsequent to the diet intervention may have also contributed to the net acid load.

Nimrit Goraya, MD (Texas A and M College of Medicine) and her colleagues looked to see if adding fruits and vegetables which are highly alkaline can benefit CKD patients with less severe metabolic acidosis. For the study, 108 patients were randomized to receive added fruits and vegetables, an oral alkaline medication, or nothing. After three years, consuming either fruits and vegetables or the oral medication reduced a marker of metabolic acidosis and preserved kidney function to similar extents. The finding was presented during the American Society of Nephrology's Annual Kidney Week.

The authors of the paper entitled Dietary Choices by Renal Transplant Recipients and Overall Acid-Base Balance (2012) went on to mention that, based on their models, consuming 100 g of vegetables and 100 g of fruit while eliminated 50 g of meat and 20 g of cheese could reduce NAE by 15 mEq/day, resulting in a serum bicarbonate increase of 0.5 mmol/L. This change could theoretically lead to a 5 per cent reduction in the metabolic acidosis prevalence. Present study says there are scope of improved kidney health in those consuming extra fruits and vegetables, which belongs to alkaline group.

In the light of above discussion we can conclude that low acid diet has important role in improvement of Chronic kidney disease as we can see in the shift of disease stage with the improvement of dietary practices and serum bicarbonate level.

Limitation of the study :

Sample size of the study was small due to that further statistical analysis was not applied, so there is a scope for further studies on larger population for generalising the findings.

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